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ABSTRACT

BACKGROUND. Beginning in 2002 the Advisory Committee on Immunization Practices encouraged, when feasible, annual influenza vaccination of all children aged 6 to 23 months and household contacts and out-of-home caregivers of children <2 years of age.

OBJECTIVE. We sought to report influenza vaccination coverage for the 2002–2003 and 2003–2004 influenza seasons among children aged 6 to 23 months according to demographic and immunization-provider characteristics.

METHODS. Data from the 2003 and 2004 National Immunization Survey were analyzed. Two measures of childhood influenza vaccination are reported: receipt of ≥1 influenza vaccination and full vaccination (ie, receipt of the appropriate number of doses on the basis of previous vaccination history). χ^2 tests and logistic-regression analyses to test for associations between influenza vaccination status and demographic characteristics were performed.

RESULTS. In the 2002–2003 and 2003–2004 influenza seasons only 7.4% and 17.5%, respectively, of children aged 6 to 23 months received ≥1 influenza vaccination, whereas only 4.4% and 8.4%, respectively, were fully vaccinated. In both seasons, adjusted influenza vaccination coverage was significantly lower among children living below the poverty level; non-Hispanic black children; older children; children with less-educated mothers; children vaccinated only at public clinics; and children not residing in a metropolitan statistical area.

CONCLUSIONS. During the first 2 years of the Advisory Committee on Immunization Practices' encouragement for children aged 6 to 23 months to receive influenza vaccination, coverage was low, with significant demographic differences in receipt of vaccination. Beginning with the 2004–2005 influenza season, they replaced the encouragement with a recommendation that children aged 6 to 23 months receive annual influenza vaccination. Substantial work remains to fully and equitably implement this new recommendation and ensure vaccination with 2 doses for previously unvaccinated children.

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Key Words
influenza, influenza vaccination, vaccination coverage

Abbreviations
ACIP—Advisory Committee on Immunization Practices
NIS—National Immunization Survey
UTD—up-to-date
4:3:1:3:3—≥4 doses of diphtheria and tetanus toxoids and pertussis vaccine, ≥3 doses of poliovirus vaccine, ≥1 dose of any measles-containing vaccine, ≥3 doses of *Haemophilus influenzae* type b vaccine, and ≥3 doses of hepatitis B vaccine
MSA—metropolitan statistical area
CI—confidence interval
OR—odds ratio
VFC—Vaccines for Children
BRFSS—Behavioral Risk Factor Surveillance System

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DURING 1990–1999, INFLUENZA caused an average of ~36 000 underlying circulatory and respiratory deaths per year in the United States; >90% of these deaths occurred in persons aged ≥65, and one quarter of 1% (0.25%) occurred in children <5 years of age.[1] Although children do not represent a large percentage of the deaths from influenza, studies have shown that children carry a large burden of hospitalizations resulting from influenza.[2–5] During 1979–2001, influenza was associated with an average of >200 000 primary respiratory and circulatory hospitalizations per year, with ~20 000 (10%) of these hospitalizations for children <5 years of age.[4] The rates of influenza-related hospitalizations among children aged <5 years ranged from ~100 in 100 000 children for those without high-risk conditions to 500 in 100 000 children for those with high-risk medical conditions; the highest rates were among children aged <2 years, which were comparable to rates of persons ≥65 years.[5]

Because children <2 years of age have been found to be at increased risk of influenza-related hospitalization, beginning in 2002 the Advisory Committee on Immunization Practices (ACIP) encouraged, when feasible, that all children 6 to 23 months of age, and the household contacts and out-of-home caregivers of children <2 years of age, receive influenza vaccination each influenza season.[2,3,6] Children <6 months are not eligible for influenza vaccination. Beginning with the 2004–2005 influenza season, the ACIP strengthened the encouragement to a recommendation.[5]

Here we examine influenza vaccination coverage for the 2002–2003 and 2003–2004 influenza seasons among children aged 6 to 23 months according to various demographic and immunization-provider characteristics.

METHODS

Data from the 2003 and 2004 National Immunization Survey (NIS) were analyzed. The NIS is an ongoing random-digit-dial telephone household survey followed by a mail survey to children's vaccination providers that provides estimates of vaccination coverage among noninstitutionalized children aged 19 to 35 months at the time of the household interview. The survey is conducted in each of the 50 states and 28 selected urban areas.[7,8] In 2003, collection of each child's entire influenza vaccination history was added to the instrument by which providers report children's vaccination histories to the NIS. Children included in the 2003 NIS were born from January 2000 through July 2002, and children included in the 2004 NIS were born from January 2001 through July 2003.

Two measures of childhood influenza vaccination coverage, based on provider-reported dates of vaccination, are reported for each influenza season. Using the 2003 NIS to obtain estimates for the 2002–2003 influenza season, the 2 measures were defined as (1) receipt of ≥1 influenza vaccination during September 1, 2002, to December 31, 2002, and (2) full vaccination, based on ACIP recommendations that children <9 years of age and previously unvaccinated against influenza should receive 2 doses, whereas all previously vaccinated children <9 years of age require only 1 dose.[5] For this second measure, children were considered fully vaccinated if they had (1) received no doses of influenza vaccine before September 1, 2002, but then received 2 doses between September 1, 2002, and January 31, 2003 (or interview date if interviewed in January), or (2) received at least 1 dose of influenza vaccine before September 1, 2002, and then received at least 1 dose between September 1, 2002, and December 31, 2002. Because children <6 months of age are not eligible for vaccination and the encouragement (and now the recommendation) is for vaccination of children 6 to 23 months, we restricted analyses for both measures to include only those children who were 6 to 23 months of age during the entire span of September 1, 2002, to December 31, 2002. A similar methodology and time frames were used to analyze the 2004 NIS.

Respondent-reported demographic characteristics included child's race/ethnicity (Hispanic, white non-Hispanic, black non-Hispanic, Asian non-Hispanic, American Indian/Alaska Native, or all other non-Hispanic), first-born status, and gender; maternal age (≤19, 20–29, or ≥30 years), education level (<12 years, 12 years, >12 years noncollege graduate, or college graduate), and marital status (widowed/divorced/separated, never married, married); poverty status (above the poverty threshold and more than $75 000/year, above the poverty threshold and $75 000/year or less, below the poverty threshold, or unknown), number of children <18 years old in the household (1, 2–3, or ≥4), and mobility (moved from a different state since birth, did not move, or unknown). Poverty status was defined using US Census Bureau poverty thresholds. American Indian, Alaska Native, and other non-Hispanic respondents were aggregated to satisfy minimum standards of statistical stability of coverage estimates (eg, observations in numerator >30). Provider-reported data included facility type at which vaccinations were received (all public clinics, all hospitals, all private practices, or other/mixed/unknown) and up-to-date (UTD) 4:3:1:3:3 (receipt, by age 19–35 months [child's date at time of interview for inclusion in the NIS], of ≥4 doses of diphtheria and tetanus toxoids and pertussis vaccine, ≥3 doses of poliovirus vaccine, ≥1 dose of any measles-containing vaccine, ≥3 doses of *Haemophilus influenzae* type b vaccine, and ≥3 doses of hepatitis B vaccine) vaccination coverage. Other demographics included census region (Northeast, Midwest, South, West), metropolitan statistical area (MSA) designation (MSA central city, MSA noncentral city, non-MSA), child's age at the start of the influenza season (September 1), and shot-card usage.

χ^2 analyses were performed, to test for associations between influenza vaccination status and demographic characteristics, and were followed by posthoc pairwise comparisons; percentages are reported with 95% confidence interval (CI) half-widths. Two sets of logistic-regression analyses were performed to determine variables independently associated with (1) receipt of ≥1 influenza vaccination or (2) being fully vaccinated for influenza. We selected the reference categories so that the odds ratios (ORs) were ≥1. Both models were run while including and then excluding the variable 4:3:1:3:3 UTD status. ORs are reported with 95% CIs. Data were weighted to adjust for households with multiple telephone lines, for unit nonresponse, for nonassessment of households without telephones, and to adjust to known population control estimates.[7–9] National estimates were obtained by using these weighting adjustments. A 2-sided significance level of .05 was adopted for all statistical tests. All analyses were conducted by using SAS 9.1 (SAS Institute, Inc, Cary, NC) and SUDAAN 9.0.0 (Research Triangle Institute, Research Triangle Park, NC), a statistical package designed for analyses of complex survey data.

RESULTS

The Council of American Survey Research Organizations response rates, a standard approach for measuring response rates for random-digit-dial surveys, for the 2003 and 2004 NIS were 69.8% and 73.1%, respectively; health care provider vaccination records were then obtained for 68.9% (21 310) and 71.6% (21 998) of the children, respectively. For the 2002–2003 influenza season we restricted our analyses to 13 831 children (unweighted) who were 6 to 23 months of age during the entire span of September 1, 2002, to December 31, 2002; for the 2003–2004 season we restricted our analyses to 13 881 children (unweighted) who were aged 6 to 23 months of age during the entire span of September 1, 2003, to December 31, 2003. The data included in this study, although a subset of the 2003 NIS and 2004 NIS data sets, are a nationally representative sample of children. Table 1 displays the demographic characteristics of children included in this study, which are consistent with characteristics of the entire NIS sample for each year.

In the 2002–2003 and 2003–2004 influenza seasons, only 7.4% (±0.7%) and 17.5% (±1.1%), respectively, of the children received at least 1 dose of influenza vaccine, and 4.4% (±0.5) and 8.4% (±0.8), respectively, were fully vaccinated (Table 2). In the 2002–2003 season, of the 7.4% who received at least 1 dose, 40% were not fully vaccinated; in the 2003–2004 season, of the 17.5% who received at least 1 dose, 52% were not fully vaccinated.

Table 2 includes influenza vaccination coverage according to demographic characteristics. Hispanic and non-Hispanic black children had significantly lower influenza vaccination coverage than both non-Hispanic white and non-Hispanic Asian children. Children in households with lower income levels had lower influenza vaccination coverage than children in households that were well above the poverty level. Children of mothers who had lower education, were unmarried, or were younger had lower influenza vaccination coverage than children of mothers who were college educated, married, and older. Living in a household with ≥4 children was associated with lower vaccination coverage compared with living in a household with fewer children. Children who received all of the vaccines from public clinics had lower influenza vaccination coverage than children who received their vaccinations at other facility types, and children residing in non-MSA areas had lower influenza vaccination coverage than those residing in other areas.

Results of the multivariable logistic-regression models to examine the association between demographic characteristics and (1) receipt of ≥1 influenza vaccination and (2) being fully vaccinated while controlling for all other demographics in the model are presented in Table 3 for the 2 influenza seasons. Child's race (white, Asian), poverty status (higher income), younger age at the start of the influenza season, and provider facility type (private and hospitals) all remained significantly associated with receipt of ≥1 influenza vaccination while controlling for other demographics for both the 2002–2003 and 2003–2004 influenza seasons. Child's race (Asian [in the 2002–2003 model] and white [in the 2003–2004 model]), mother's education (college graduate), MSA (central city [in the 2002–2003 model] and noncentral city [in the 2003–2004 model]), and provider facility type (private) all remained significantly associated with being fully vaccinated for influenza for both influenza seasons (Table 3).

The above-described models were recomputed including 4:3:1:3:3 UTD status in addition to the other demographic variables (data not shown). For the models examining associations with ≥1 influenza vaccination, the 4:3:1:3:3 UTD variable dominated the models (ie, had a very large OR); children 4:3:1:3:3 UTD had an OR of 3.1 (95% CI: 2.2–4.3) in 2002–2003 and 2.3 (95% CI: 1.8–2.9) in 2003–2004 of receiving ≥1 influenza vaccination compared with children who were not 4:3:1:3:3 UTD. Similar results were found for the model to examine associations with being fully vaccinated for influenza; children 4:3:1:3:3 UTD had an OR of 4.0 (95% CI: 2.5–6.6) in 2002–2003 and 2.7 (95% CI: 1.9–4.0) in 2003–2004 of being fully vaccinated for influenza compared with children who were not 4:3:1:3:3 UTD.

DISCUSSION

Our findings indicate that during the first 2 influenza seasons that the ACIP encouraged influenza vaccination

TABLE 1 **Distribution of Samples According to Demographic Characteristics**

Demographic Characteristic	2002–2003 Influenza Season[a]		2003–2004 Influenza Season[b]	
	Unweighted *n*	Weighted % (±95% CI Half-width)	Unweighted *n*	Weighted % (±95% CI Half-width)
Overall	13 831	100.0	13 881	100.0
Child's race/ethnicity				
Hispanic	2958	26.8 (±1.2)	2877	27.9 (±1.4)
White, non-Hispanic	8143	53.5 (±1.3)	8387	52.4 (±1.5)
Black, non-Hispanic	1913	13.9 (±1.0)	1780	14.0 (±1.1)
Asian, non-Hispanic	616	4.8 (±0.7)	646	4.6 (±0.6)
American Indian/Alaska Native and other, non-Hispanic	201	1.1 (±0.2)	191	1.1 (±0.3)
First born				
No	8351	61.5 (±1.3)	8435	63.1 (±1.4)
Yes	5480	38.5 (±1.3)	5446	36.9 (±1.4)
Gender				
Male	7054	50.8 (±1.4)	7083	51.0 (±1.5)
Female	6777	49.2 (±1.4)	6798	49.0 (±1.5)
Poverty status[c]				
Above, more than $75 000/y	2885	15.0 (±0.8)	3309	16.3 (±0.9)
Above, $75 000/y or less	6932	46.7 (±1.4)	6735	45.1 (±1.5)
Below	2743	24.5 (±1.3)	2611	26.3 (±1.5)
Unknown	1271	13.8 (±1.1)	1226	12.3 (±1.1)
Child's age at start of the influenza season				
6–11 mo	4041	29.2 (±1.3)	3816	27.0 (±1.4)
12–16 mo	6124	44.1 (±1.4)	6335	46.1 (±1.5)
17–20 mo	3666	26.7 (±1.2)	3730	26.9 (±1.3)
Mother's education level				
<12 y	1953	23.0 (±1.3)	1703	22.3 (±1.5)
12 y	3574	30.6 (±1.3)	3490	31.0 (±1.4)
>12 y, noncollege graduate	2636	21.4 (±1.1)	2634	21.4 (±1.2)
College graduate	5668	25.0 (±1.0)	6054	25.3 (±1.1)
Mother's marital status				
Widowed/divorced/separated	978	8.4 (±0.8)	853	8.4 (±0.9)
Never married	2758	23.1 (±1.2)	2582	23.2 (±1.3)
Married	10 095	68.6 (±1.3)	10 446	68.5 (±1.5)
Mother's age				
≤19 y	371	3.7 (±0.6)	334	3.2 (±0.6)
20–29 y	5789	46.8 (±1.4)	5618	47.1 (±1.5)
≥30 y	7671	49.6 (±1.4)	7929	49.7 (±1.5)
Shot card used				
Yes	6544	45.1 (±1.3)	5769	39.5 (±1.5)
No	7287	54.9 (±1.3)	8112	60.5 (±1.5)
Census region				
Northeast	2360	17.2 (±0.7)	2299	17.1 (±0.9)
Midwest	3099	21.3 (±0.8)	3143	21.7 (±0.9)
South	5147	37.2 (±1.0)	5087	36.3 (±1.1)
West	3225	24.3 (±0.9)	3352	24.8 (±1.1)
MSA				
MSA, central city	6084	35.2 (±1.2)	6124	36.3 (±1.4)
MSA, noncentral city	4896	46.9 (±1.3)	4887	45.4 (±1.5)
Non-MSA	2851	17.9 (±0.9)	2870	18.3 (±1.0)
No. of children <18 y old in household				
1	3841	26.6 (±1.2)	3884	26.1 (±1.3)
2–3	8334	59.3 (±1.4)	8323	60.3 (±1.5)
≥4	1656	14.2 (±1.1)	1674	13.5 (±1.1)
Provider facility type				
All public	1967	15.5 (±1.0)	1776	15.8 (±1.2)
All hospitals	1259	8.7 (±0.8)	1275	8.2 (±0.8)
All private	8569	61.3 (±1.3)	8610	60.9 (±1.5)
Other, mixed, unknown	1966	14.6 (±1.0)	2147	15.1 (±1.1)
Moved from a different state[d]				
Moved	1070	8.4 (±0.8)	985	7.5 (±0.8)
Did not move	12 722	91.6 (±0.8)	12 871	92.5 (±0.8)
4:3:1:3:3				
UTD	11 060	78.5 (±1.2)	11 296	79.8 (±1.2)
Not UTD	2771	21.5 (±1.2)	2585	20.2 (±1.2)

[a] Influenza vaccination coverage measures for the 2002–2003 influenza season are based on data from the 2003 NIS and represent a subset of children included in the NIS. Only those who were between the ages of 6 and 23 months for the entire period of September 1, 2002, to December 31, 2002, are included in the influenza vaccination coverage measures.

[b] Influenza vaccination coverage measures for the 2003–2004 influenza season are based on data from the 2004 NIS and represent a subset of children included in the NIS. Only those who were between the ages of 6 and 23 months for the entire period of September 1, 2003, to December 31, 2003 are included in the influenza vaccination coverage measures.

[c] Defined using US Census Bureau poverty thresholds.

[d] Unknown responses were excluded ($n = 39$ for 2002–2003 and $n = 25$ for 2003–2004).

TABLE 2 **Influenza Vaccination Coverage Levels Among Children Aged 6 to 23 Months According to Demographic Characteristics**

Demographic Characteristic	2002–2003 Influenza Season[a]				2003–2004 Influenza Season[b]			
	1+FLU[c]		Fully Vaccinated[d]		1+FLU[e]		Fully Vaccinated[f]	
	% (±95% CI Half-width)	*P*	% (±95% CI Half-width)	*P*	% (±95% CI Half-width)	*P*	% (±95% CI Half-width)	*P*
Overall	7.4 (±0.7)		4.4 (±0.5)		17.5 (±1.1)		8.4 (±0.8)	
Child's race/ethnicity		<.01		<.01		<.01		<.01
Hispanic	5.8 (±1.3)		2.8 (±1.0)		13.4 (±2.1)		5.0 (±1.2)	
White, non-Hispanic	8.5 (±0.8)		5.4 (±0.6)		20.6 (±1.5)		11.1 (±1.1)	
Black, non-Hispanic	4.8 (±1.5)		2.5 (±1.1)		11.3 (±3.0)		4.4 (±1.9)	
Asian, non-Hispanic	12.1 (±5.0)		8.8 (±4.7)		25.9 (±6.6)		11.7 (±5.6)	
American Indian/Alaska Native and other, non-Hispanic	3.6 (±2.6)		2.1 (±2.2)		20.9 (±8.4)		6.6 (±3.9)	
First born		<.01		<.01		<.01		<.01
No	6.3 (±0.8)		3.5 (±0.6)		16.1 (±1.4)		7.3 (±0.9)	
Yes	9.1 (±1.1)		5.8 (±0.9)		20.0 (±1.8)		10.4 (±1.4)	
Gender		.96		.98		.72		.70
Male	7.4 (±0.9)		4.4 (±0.7)		17.7 (±1.6)		8.6 (±1.1)	
Female	7.4 (±1.0)		4.4 (±0.8)		17.3 (±1.5)		8.3 (±1.1)	
Poverty status[g]		<.01		<.01		<.01		<.01
Above, more than $75 000/y	14.1 (±2.0)		9.8 (±1.7)		28.6 (±2.7)		15.9 (±2.1)	
Above, $75 000/y or less	7.1 (±0.9)		3.8 (±0.6)		17.0 (±1.5)		8.2 (±1.1)	
Below	4.6 (±1.4)		2.6 (±1.2)		12.6 (±2.2)		4.3 (±1.4)	
Unknown	6.0 (±1.8)		3.6 (±1.4)		15.5 (±3.4)		8.0 (±2.7)	
Child's age at start of the influenza season		<.01		.10		<.01		.29
6–11 mo	8.1 (±1.3)		4.8 (±1.1)		20.5 (±2.4)		9.5 (±1.8)	
12–16 mo	7.9 (±1.0)		4.7 (±0.8)		17.8 (±1.6)		8.3 (±1.1)	
17–20 mo	5.6 (±1.1)		3.6 (±0.9)		14.1 (±1.8)		7.7 (±1.4)	
Mother's education level		<.01		<.01		<.01		<.01
<12 y	4.9 (±1.4)		1.9 (±0.8)		11.6 (±2.4)		3.9 (±1.6)	
12 y	5.7 (±1.2)		3.3 (±1.0)		16.1 (±2.1)		7.0 (±1.4)	
>12 y, non–college graduate	7.7 (±1.5)		4.6 (±1.2)		15.7 (±2.2)		7.8 (±1.7)	
College graduate	11.4 (±1.2)		7.9 (±1.1)		26.1 (±1.9)		14.7 (±1.6)	
Mother's marital status		<.01		<.01		<.01		<.01
Widowed/divorced/separated	4.5 (±1.6)		2.1 (±1.2)		11.8 (±3.2)		3.7 (±1.8)	
Never married	6.3 (±1.5)		2.7 (±0.9)		13.5 (±2.2)		4.5 (±1.1)	
Married	8.1 (±0.8)		5.3 (±0.7)		19.6 (±1.4)		10.3 (±1.0)	
Mother's age		<.01		<.01		<.01		<.01
≤19 y	6.6 (±4.6)		1.5 (±1.4)		14.4 (±7.4)		3.6 (±2.9)	
20–29 y	6.3 (±1.0)		3.5 (±0.8)		14.4 (±1.6)		6.1 (±1.1)	
≥30 y	8.4 (±0.9)		5.4 (±0.7)		20.7 (±1.5)		11.0 (±1.2)	
Shot card used		.69		.99		.77		.41
Yes	7.2 (±0.9)		4.4 (±0.7)		17.7 (±1.8)		8.9 (±1.4)	
No	7.5 (±0.9)		4.4 (±0.7)		17.4 (±1.4)		8.2 (±0.9)	
Census region		<.01		<.01		.06		.01
Northeast	7.8 (±1.5)		5.0 (±1.2)		20.8 (±2.7)		10.0 (±1.9)	
Midwest	9.2 (±1.4)		5.4 (±1.0)		17.6 (±2.1)		9.8 (±1.6)	
South	6.1 (±0.9)		3.3 (±0.6)		16.4 (±1.8)		7.0 (±1.1)	
West	7.4 (±1.6)		4.9 (±1.4)		16.8 (±2.5)		8.3 (±1.9)	
MSA		.01		<.01		<.01		<.01
MSA, central city	7.4 (±1.0)		4.3 (±0.8)		15.9 (±1.6)		7.2 (±1.0)	
MSA, noncentral city	8.1 (±1.1)		5.1 (±0.9)		20.6 (±1.9)		10.3 (±1.4)	
Non-MSA	5.5 (±1.3)		2.8 (±0.8)		13.1 (±1.9)		6.3 (±1.4)	
No. of children <18 y old in household		<.01		<.01		<.01		<.01
1	9.5 (±1.3)		5.7 (±1.0)		20.8 (±2.1)		11.2 (±1.7)	
2–3	7.3 (±0.9)		4.4 (±0.7)		17.2 (±1.4)		7.9 (±1.0)	
≥4	3.8 (±1.4)		1.9 (±1.1)		12.7 (±2.9)		5.3 (±1.8)	
Provider facility type		<.01		<.01		<.01		<.01
All public	3.2 (±1.2)		1.8 (±1.0)		10.3 (±2.4)		4.0 (±1.4)	
All hospitals	6.9 (±2.1)		3.1 (±1.4)		18.6 (±3.7)		6.3 (±1.9)	
All private	8.8 (±0.9)		5.5 (±0.7)		20.3 (±1.5)		10.2 (±1.1)	
Other, mixed, unknown	6.2 (±1.6)		3.5 (±1.2)		13.9 (±2.5)		7.2 (±2.0)	
Moved from a different state[h]		<.01		<.01		.06		.04
Moved	4.9 (±1.7)		2.7 (1.2)		14.0 (±3.7)		5.8 (±2.6)	
Did not move	7.6 (±0.7)		4.6 (0.5)		17.8 (±1.1)		8.7 (±0.8)	
4:3:1:3:3		<.01		<.01		<.01		<.01
UTD	8.7 (±0.8)		5.3 (±0.6)		19.7 (±1.3)		9.8 (±0.9)	
Not UTD	2.7 (±0.8)		1.1 (±0.5)		8.9 (±1.7)		3.2 (±1.1)	

[a] Influenza vaccination coverage measures for the 2002–2003 influenza season are based on data from the 2003 NIS and represent a subset of children included in the NIS. Only those who were between the ages of 6 and 23 months for the entire period of September 1, 2002, to December 31, 2002, are included in the influenza vaccination coverage measures ($n = 13\,831$ [unweighted]).

[b] Influenza vaccination coverage measures for the 2003–2004 influenza season are based on data from the 2004 NIS and represent a subset of children included in the NIS. Only those who were between the ages of 6 and 23 months for the entire period of September 1, 2003, to December 31, 2003, are included in the influenza vaccination coverage measures ($n = 13\,881$ [unweighted]).

[c] Receipt of ≥1 influenza vaccination between September 1, 2002, and December 31, 2002.

[d] Children were considered fully vaccinated if they had (1) received no doses of influenza vaccine before September 1, 2002, but then received 2 doses between September 1, 2002, and either the date of interview or January 31, 2003, or (2) received at least 1 dose of influenza vaccine before September 1, 2002, and then received at least 1 between September 1, 2002, and December 31, 2002.

[e] Receipt of ≥1 influenza vaccination between September 1, 2003, and December 31, 2003.

[f] Children were considered fully vaccinated if they had (1) received no doses of influenza vaccine before September 1, 2003, but then received 2 doses between September 1, 2003, and either the date of interview or January 31, 2004, or (2) received at least 1 dose of influenza vaccine before September 1, 2003, and then received at least 1 between September 1, 2003, and December 31, 2003.

[g] Defined using US Census Bureau poverty thresholds.

[h] Unknown responses were excluded ($n = 39$ for 2002–2003 and $n = 25$ for 2003–2004).

TABLE 3 **Multivariable Logistic-Regression Analyses of Influenza Vaccination Coverage Levels Among Children Aged 6 to 23 Months and Demographic Characteristics**

Demographic Characteristic	2002–2003 Influenza Season[a]		2003–2004 Influenza Season[b]	
	1+FLU, Adjusted OR (95% CI)[c]	Fully Vaccinated, Adjusted OR (95% CI)[d]	1+FLU, Adjusted OR (95% CI)[e]	Fully Vaccinated, Adjusted OR (95% CI)[f]
Child's race/ethnicity				
Hispanic	1.4 (0.9–2.2)	1.2 (0.7–2.2)	1.3 (0.9–1.9)	1.1 (0.6–2.0)
White, non-Hispanic	1.5 (1.0–2.2)[g]	1.5 (1.0–2.5)	1.7 (1.2–2.4)[h]	1.8 (1.0–3.0)[g]
Black, non-Hispanic	Referent	Referent	Referent	Referent
Asian, non-Hispanic	2.1 (1.1–3.8)[g]	2.2 (1.1–4.7)[g]	2.0 (1.2–3.3)[h]	1.6 (0.7–3.5)
American Indian/Alaska Native and other, non-Hispanic	0.9 (0.4–2.1)	1.0 (0.3–3.2)	2.8 (1.5–5.1)[h]	1.8 (0.8–4.1)
First born				
No	0.8 (0.6–1.1)	0.6 (0.4–0.9)[g]	0.9 (0.7–1.2)	0.9 (0.6–1.3)
Yes	Referent	1.0 Referent	Referent	Referent
Gender				
Male	1.0 (0.8–1.2)	1.0 (0.8–1.3)	1.1 (0.9–1.2)	1.1 (0.9–1.3)
Female	Referent	Referent	Referent	Referent
Poverty status[i]				
Above, more than $75 000/y	2.1 (1.3–3.4)[h]	1.6 (0.8–3.1)	1.4 (1.1–1.9)[g]	1.4 (0.9–2.2)
Above, $75 000/y or less	1.2 (0.8–1.9)	0.8 (0.5–1.5)	1.0 (0.8–1.3)	1.1 (0.7–1.6)
Below	Referent	Referent	Referent	Referent
Unknown	1.1 (0.7–1.8)	.0 (0.5–2.0)	1.0 (0.7–1.5)	1.3 (0.8–2.2)
Child's age at start of the influenza season				
6–11 mo	1.5 (1.1–2.0)[h]	1.4 (1.0–2.0)[g]	1.7 (1.3–2.1)[h]	1.3 (1.0–1.7)
12–16 mo	1.4 (1.1–1.8)[h]	1.3 (1.0–1.8)	1.4 (1.1–1.7)[h]	1.1 (0.9–1.4)
17–20 mo	Referent	Referent	Referent	Referent
Mother's education level				
<12 y	Referent	Referent	Referent	Referent
12 y	1.0 (0.7–1.5)	1.4 (0.8–2.5)	1.3 (0.9–1.7)	1.4 (0.8–2.3)
>12 y, non–college graduate	1.3 (0.8–2.0)	1.7 (0.9–3.2)	1.1 (0.8–1.5)	1.2 (0.7–2.1)
College graduate	1.4 (0.9–2.1)	2.1 (1.2–3.7)[g]	1.5 (1.1–2.1)[h]	1.7 (1.0–3.0)[g]
Mother's marital status				
Widowed/divorced/separated	Referent	Referent	Referent	Referent
Never married	1.5 (1.0–2.4)	1.5 (0.8–2.9)	1.4 (0.9–2.0)	1.5 (0.9–2.7)
Married	1.3 (0.8–1.9)	1.7 (0.9–3.2)	1.4 (1.0–2.0)	2.0 (1.1–3.5)[g]
Mother's age				
≤19 y	Referent	Referent	Referent	Referent
20–29 y	0.8 (0.4–1.8)	1.7 (0.6–4.8)	0.8 (0.5–1.5)	1.3 (0.6–3.0)
≥30 y	0.8 (0.4–1.9)	1.8 (0.6–5.2)	1.0 (0.5–1.8)	1.6 (0.7–3.9)
Shot card used				
Yes	1.0 (0.8–1.2)	1.0 (0.8–1.3)	1.0 (0.9–1.2)	1.1 (0.9–1.4)
No	Referent	Referent	Referent	Referent
Census region				
Northeast	1.1 (0.8–1.4)	1.2 (0.8–1.7)	1.0 (0.8–1.3)	1.1 (0.8–1.4)
Midwest	1.5 (1.1–1.9)[h]	1.5 (1.1–2.0)[h]	1.0 (0.8–1.2)	1.2 (1.0–1.6)
South	Referent	Referent	Referent	Referent
West	1.1 (0.9–1.5)	1.4 (1.0–1.9)	0.9 (0.7–1.2)	1.1 (0.8–1.5)
MSA				
MSA, central city	1.3 (0.9–1.7)	1.5 (1.0–2.1)[g]	1.3 (1.0–1.6)[g]	1.2 (0.9–1.7)
MSA, noncentral city	1.1 (0.8–1.5)	1.3 (0.9–1.9)	1.4 (1.2–1.8)[h]	1.4 (1.0–1.9)[g]
Non-MSA	Referent	Referent	Referent	Referent
No. of children <18 y old in household				
1	1.7 (1.0–2.8)[g]	1.6 (0.8–3.2)	1.3 (0.9–2.0)	1.5 (0.9–2.6)
2–3	1.6 (1.0–2.4)[g]	1.8 (0.9–3.3)	1.2 (0.9–1.6)	1.2 (0.8–1.8)
≥4	Referent	Referent	Referent	Referent
Provider facility type				
All public	Referent	Referent	Referent	Referent
All hospitals	1.9 (1.1–3.2)[g]	1.4 (0.7–2.8)	1.7 (1.2–2.5)[h]	1.3 (0.8–2.2)
All private	2.1 (1.4–3.2)[h]	1.9 (1.0–3.4)[g]	1.5 (1.1–2.1)[h]	1.6 (1.0–2.4)[g]
Other, mixed, unknown	1.8 (1.1–2.9)[g]	1.6 (0.9–3.1)	1.2 (0.8–1.6)	1.4 (0.8–2.3)
Moved from a different state				
Moved	Referent	Referent	Referent	Referent
Did not move	1.5 (1.0–2.3)[g]	1.7 (1.1–2.8)[g]	1.3 (0.9–1.8)	1.5 (0.9–2.5)

[a] Influenza vaccination coverage measures for the 2002–2003 influenza season are based on data from the 2003 NIS and represent a subset of children included in the NIS. Only those who were between the ages of 6 and 23 months for the entire period of September 1, 2002, to December 31, 2002, are included in the influenza vaccination coverage measures (n = 13 831 [unweighted]).
[b] Influenza vaccination coverage measures for the 2003–2004 influenza season are based on data from the 2004 NIS and represent a subset of children included in the NIS. Only those who were between the ages of 6 and 23 months for the entire period of September 1, 2003, to December 31, 2003, are included in the influenza vaccination coverage measures (n = 13 881 [unweighted]).
[c] Receipt of ≥1 influenza vaccination between September 1, 2002, and December 31, 2002.
[d] Children were considered fully vaccinated if they had (1) received no doses of influenza vaccine before September 1, 2002, but then received 2 doses between September 1, 2002, and either the date of interview or January 31, 2003, or (2) received at least 1 dose of influenza vaccine before September 1, 2002, and then received at least 1 between September 1, 2002, and December 31, 2002.
[e] Receipt of ≥1 influenza vaccination between September 1, 2003, and December 31, 2003.
[f] Children were considered fully vaccinated if they had (1) received no doses of influenza vaccine before September 1, 2003, but then received 2 doses between September 1, 2003, and either the date of interview or January 31, 2004, or (2) received at least 1 dose of influenza vaccine before September 1, 2003, and then received at least 1 between September 1, 2003, and December 31, 2003.
[g] $P < .05$ for comparison with the referent group.
[h] $P < .01$ for comparison with the referent group.
[i] Defined using US Census Bureau poverty thresholds.

for all children aged 6 to 23 months, influenza coverage was low and there was significant variability according to demographic and immunization-provider characteristics. In addition, of the 7.4% and 17.5% of children receiving ≥1 dose of influenza vaccine in the 2 influenza seasons, 40% and 52%, respectively, did not receive their second dose to become fully vaccinated and thus were suboptimally protected against influenza.

The pattern of differences we found in influenza vaccination coverage according to demographic characteristics is similar to differences in coverage reported in studies of other childhood immunizations.[10–13] Previous studies have found lower 4:3:1:3 (defined as receipt of ≥4 doses of diphtheria and tetanus toxoids and pertussis vaccine, ≥3 doses of poliovirus vaccine, ≥1 dose of any measles-containing vaccine, and ≥3 doses of *H influenzae* type b vaccine) and 4:3:1:3:3 coverage among children living below the poverty level.[10,12] Lower maternal education level and a larger number of children in the household has also been found to be associated with low vaccination coverage with childhood vaccines.[13] We found that children vaccinated at only public clinics had lower influenza vaccination coverage than those vaccinated elsewhere or at a mixture of facility types; this has been found for other childhood vaccinations as well.[12]

Although our study demonstrated low influenza vaccination coverage among children of all races/ethnicities, we found that black non-Hispanic children had lower vaccination coverage than both white non-Hispanic and Asian non-Hispanic children. Although racial and ethnic disparities in routine vaccination coverage among children have been reduced substantially, a recent study by Chu et al[14] reported that a disparity in 4:3:1:3:3 UTD immunization coverage between white non-Hispanic and black non-Hispanic children has been increasing in recent years. Other studies of influenza vaccination have consistently found large disparities between non-Hispanic white and non-Hispanic black elderly adults.[5,15–22] The racial/ethnic disparity in childhood influenza vaccination coverage found in this study will require careful monitoring and targeted interventions that are effective in reversing the trend, if it continues over time, to mirror the adult influenza vaccination disparity.

Influenza vaccination of all children aged 6 to 23 months represents a unique challenge to immunization providers. It is different from other routinely recommended childhood vaccinations because influenza vaccination must be administered annually and during a fairly limited time period. Also complicating influenza vaccination of young children is the recommendation that children aged ≤8 years receiving the vaccine for the first time should receive 2 doses, scheduled at least 4 weeks apart.[23] Receipt of 2 doses for previously unvaccinated children is paramount, because receipt of only 1 dose may provide little to no protection; in studies of pediatric influenza vaccine effectiveness, receipt of only 1 dose of vaccine among previously unvaccinated children <2 years of age was found to not provide protection compared with 2 doses.[24–26] Thus, efforts directed at maximizing the number of children who are fully vaccinated each season are particularly important to optimize protection from influenza.

The feasibility of implementation of the influenza vaccination recommendation to all children aged 6 to 23 months was studied recently.[27–31] Implementation of the universal influenza vaccination has been estimated to substantially increase the number of provider visits required to become fully vaccinated for influenza, with as many as 74% of 6- to 23-month-olds requiring at least 1 additional visit for vaccination if only well-child care visits were used for vaccination.[29] Vaccination clinics or sessions at which many children can be vaccinated for influenza have been suggested as a way to manage the large increase in visits.[27,28,30] Providers have also expressed concern about the inability to identify children who are eligible for vaccination; tracking of eligible children and reminder/recall systems may facilitate implementation of this universal recommendation by addressing this barrier.[27] Although new vaccine recommendations often raise concerns about their impact on the delivery of other vaccines, a recent study examining influenza vaccination of 6- to 23-month-olds within a group of inner-city clinics did not reveal an associated delay in receipt of the other recommended vaccines.[31]

During the 2002–2003 influenza season, expanded pediatric influenza vaccination had not yet been included in the Vaccines for Children (VFC) program and may not have been covered by the majority of private health plans. Both the lack of VFC program and insurance coverage for this vaccine and the lack of a full recommendation likely contributed to the low coverage observed in 2002–2003. Beginning in the 2003–2004 influenza season, however, the ACIP voted to include annual influenza vaccination for 6- to 23-month-old children and the household contacts of children <2 years of age in the VFC program. This expansion of VFC program coverage for influenza vaccine enables providers to administer public-purchased influenza vaccine to the most vulnerable groups of children (ie, Medicaid enrollees, the uninsured, Native American/Alaska Native children, and children whose health insurance does not cover the cost of vaccination when they are served in federally qualified or rural health centers). This program reduces out-of-pocket costs for the parents of these children, which is an evidence-based strategy for increasing immunization coverage levels.[32]

Influenza vaccine supply was unlikely to have contributed to the low vaccination coverage in the 2002–2003 influenza season, because there were no influenza vaccine shortages or delays during that season. Although there was not a vaccine-supply shortage during the 2003–2004 season, the season was unusual in several

respects. Influenza activity began earlier than most seasons, with peak activity occurring in December, and it was a moderately severe season in terms of mortality.[33] There were 152 influenza-associated deaths of children in the United States reported to the Centers for Disease Control and Prevention.[33] The substantial publicity surrounding these influenza-related deaths of children and the early onset of the influenza season led to a large increase in demand for influenza vaccine, exceeding demand in previous years.

During the subsequent 2004–2005 season, a dramatic influenza vaccine-supply shortage prompted the addition of questions to the Behavioral Risk Factor Surveillance System (BRFSS) to rapidly assess influenza vaccination coverage. National reported vaccination coverage data from September 1, 2004, to January 31, 2005, collected in February 2005 indicated that coverage with at least 1 dose of influenza vaccine for children aged 6 to 23 months was 48.4%.[34] Although a comparison of these results with findings from our study must be interpreted with caution because of the different methods used by the 2 surveys, the BRFSS assessment suggests that progress was made in implementation of influenza vaccination among 6- to 23-month-old children between 2002 and 2004. An important methodologic difference between the surveys is the reliance of BRFSS on parental report of pediatric influenza vaccination, whereas the NIS uses only provider-reported data; the validity of parental report of pediatric influenza vaccination is not known at this time. In addition, the BRFSS survey did not assess the proportion of children vaccinated with 1 vs 2 doses, which is critical for understanding the extent of protection offered by influenza vaccination of young children.

Despite the significant vaccine shortage in 2004, the vaccine coverage level found in BRFSS suggests that there was success in targeting vaccine to this group, which was one of the ACIP's recommended priority groups for vaccination during the shortage.[35] It is also noteworthy that among BRFSS respondents with an unvaccinated child aged 6 to 23 months, most (62.9%) thought that the vaccine was not needed for their children.[36] These results suggest that although the uptake has been higher in the first year of recommendation compared with the first 2 years of the encouragement, there remains much work to raise awareness among parents of children in this age group about the recommendation for annual influenza vaccination.

The findings in this report are subject to at least 4 limitations. First, NIS is a telephone survey, and although statistical adjustments compensate for nontelephone households, some bias might remain. Second, the NIS relies on provider-verified vaccination histories; therefore, incomplete records and reporting could result in underestimates of coverage. The third limitation has to do with 2 decisions we made in our analysis that may have influenced, in opposite directions, the vaccination coverage estimates. The first decision was that we chose to limit our analysis to only those vaccinations given from September 1 to December 31 for the ≥1-influenza-vaccination measure and September 1 to January 31 (or date of interview if interview occurred before January 31) for the fully vaccinated measure, although some vaccinations may have occurred after these months and were not counted. This approach served to lower both measures of influenza vaccination coverage reported here, particularly the estimate of fully vaccinated children, because difficulty in scheduling and returning for the second dose of influenza vaccine may result in the second dose being received later in the influenza season. The second decision was that we restricted our measurement of vaccination coverage to those who were aged 6 to 23 months during the entire influenza vaccination time period of September 1 to December 31. Children in this age group were eligible for vaccination under the ACIP encouragement for the entire period of assessment, with their caregivers and providers having the same amount of time to ensure vaccination. It is likely that this sample of children has higher vaccination coverage than children who were aged 6 to 23 months during only a portion of the 4-month vaccination interval, thereby inflating our coverage estimate. A fourth limitation was that we did not take into account the minimum 4-week interval between a first and second dose of influenza vaccine when defining our measures of immunization coverage.

CONCLUSIONS

We have found that influenza vaccination coverage among children aged 6 to 23 months was low during the first 2 years of the encouragement, with many children receiving only 1 of 2 needed doses. Continued monitoring of influenza vaccine uptake will be important to track progress and identify risk factors for undervaccination. Additional studies are needed to determine the reasons for variation in coverage reported here as well as the failure to achieve full vaccination among such a large percentage of children.

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